OBSOLESCENCE LOSS RATE

OPERATIONS ANALYSIS DEPARTMENT

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13. ABSTRACT

The purpose of this report is to review a method of calculating the obsolescence loss rate prescribed in DODI 4140.39. The report is divided into three areas of study. The first area discusses the theoretical foundations of the present and proposed obsolescence loss rates. The second area studies the proposed formulation in relation to the data available. The third analyzes the obsolescence loss rate's effect upon both constrained and unconstrained Navy inventory control procedures.

The study points out that at this time, only three years of appropriate Navy data are available from which the directed approach can be evaluated. This is not considered an adequate data base from which to make definitive statements. As specified in DODI 4140.39, a sufficient history of past computations should be at least five years. Preliminary analysis shows that the approach directed by DODI 4140.39 does produce a variable obsolescence loss rate based upon a projected disposal rate, albeit not the peacetime disposal rate desired. The greatest limitation is its high and unpredictable variability, which may partly be caused by the lack of data. In view of this, caution in implementation of this obsolescence loss rate is recommended.

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OBSOLESCENCE LOSS RATE

Report 84

Project 971158

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ABSTRACT

The purpose of this report is to review a method of calculating the obsolescence loss rate prescribed in DODI 4140.39. The report is divided into three areas of study. The first area discusses the theoretical foundations of the present and proposed obsolescence loss rates. The second area studies the proposed formulation in relation to the data available. The third analyzes the obsolescence loss rate's effect upon both constrained and unconstrained Navy inventory control procedures.

For many years the Navy has considered obsolescence losses to eminate solely from technological change. However, DODI 4140.39 provides for computation of the obsolescence loss rate based on all stocks for an item superfluous to need. The study shows that values computed under the prescribed method varied significantly from year to year. Also, for some material groupings computed values were double the values currently used at Navy ICPs (Inventory Control Points). In large measure this is attributed to large variation in the dollar value of disposals and on-hand assets. In general, sensitivity analysis revealed that, requirements determination formulae in the Navy Uniform Inventory Control Point Programs are relatively insensitive to changes in the obsolescence loss rate.

I. INTRODUCTION

Reference (1) established a standard policy throughout the DOD (Department of Defense) for determining procurement cycles and safety levels of supply for non-reparable secondary items at ICPs (Inventory Control Points). A part of this policy is the establishment of a uniform method for computing the obsolescence loss rate.

NAVSUP (Naval Supply Systems Command), by reference (2), requested FMSO (Navy Fleet Material Support Office) to validate the cited method. To do this, FMSO divided the project into the following steps:

- Evaluate the validity of DOD's obsolescence loss rate formula logic.
- Perform a sensitivity analysis of the obsolescence loss rate's effect upon the various formulae used in UICP (Uniform Inventory Control Point) programs.

The report is divided into three areas of study. The first area discusses the theoretical foundations of the present and the DOD obsolescence loss rates. The second area studies the DODI formulation in relation to the data available. The third analyzes the obsolescence loss rate's effect upon both constrained and unconstrained Navy inventory control procedures.

II. DEFINITION

A. Obsolescence Loss Rate.

The obsolescence loss rate historically has been a constant and a part of the holding cost rate. The holding cost rate is defined as:

$$I = i + \ell + s \tag{1}$$

where

I = holding cost rate

i = interest rate

ℓ = obsolescence loss rate

s = storage cost rate

This holding cost rate, in turn, appears in various formulae in UICP and affects the stocking decisions made. Obsolescence loss rate, in the past, has been viewed as a "technological" obsolescence loss rate. It was the rate at which repair parts grew obsolete. The literature has treated this loss rate as a constant. Theoretically, its use in this manner might be explained in the following way.

Initially, the expected life of an item would be estimated by an engineer. This would be defined as the upper bound year. Since technological development is dynamic, the actual phase-out year can be considered a "surprise". In fact, with a constant obsolescence loss rate, any year from the present year to the upper bound year is considered equally likely. Thus, the probability of mortality in a given year is the reciprocal of the expected life of an item.

The definition of obsolescence loss rate as directed by DOD in reference (1) changes the concept of obsolescence for the Navy. Where only those losses due to technological causes were counted in the past, now the definition encompasses technological considerations, deterioration of material, forecast errors, reduced usage, and other causes. Actually, all material transferred to disposal is included in computing the obsolescence loss rate.

Mathematically the rate is defined:

$$\ell = t/a \tag{2}$$

where

ℓ = obsolescence loss rate

t = value of property transferred to all Property Disposal Officers

a = value of applicable stratified on-hand and on-order assets

It should be emphasized that this is a projected value computed at the beginning of each fiscal year. The obsolescence loss rate changes from a constant to a variable that is computed from year to year.

Reference (1) states that an obsolescence loss rate must be computed, at a minimum, at each ICP. This study examined the loss rate by inventory segment, which resulted in a separate obsolescence loss rate for each Navy cognizance, in most cases.

B. Obsolescence Loss Rate Variables - Disposals and Assets.

Dollar value of transfers to all Property Disposal Officers is denoted by "t" in equation (2). The annual amount is determined by NAVSUP. The following procedure is currently used to make the determination. NAVSUP reviews the dollar value of excess on stratification for the previous year and the projected MTIS (Material Turn-in to Store) for the following year. From this, a dollar value goal for disposal is assigned to each ICP. Within the total dollar value goal, each ICP in turn, decides across its respective cogs, which items to transfer to disposal and directs the stock points to take appropriate action.

The stock points report disposal actions on the FIR (Financial Inventory Record). It is this report that provides the values of "t". Since it is a monthly report, the total value is obtained by summing the reports over the fiscal year. FIR report caption L1, Expenditure from Store to Property Disposal Officer, and caption C1, Returns from Surplus, apply.

Assets, denoted by "a", are obtained from the semi-annual budget stratification report. The dollar value of assets for a given fiscal year is obtained from lines A11 and A12 of TABLE I and from lines B3 and B4 of TABLE III of the report. TABLE I contains the dollar value of centrally managed material, and TABLE III contains the dollar value of locally managed material. It is emphasized that the required dollar values, as defined, have been developed in stratification only since fiscal year 1969. Thus, there is but three years of data from which statements about the obsolescence loss rate of reference (1) can be made.

Reference (1) states that these assets represent the maximum expected on-hand and on-order quantities at any point in time. This includes PWRS (Prepositioned War Reserve Stock) and peacetime stocks. At the same time, the dollar value of disposals includes <u>all</u> disposals, not just those associated with peacetime operating stock and PWRS. It was the intent of reference (1) that the effects of unusual losses such as those due to sudden acceleration or deceleration of wartime activity would not affect the obsolescence loss rate. To nullify these effects, reference (1) suggests that the obsolescence loss rate be adjusted, but it fails to provide guidance.

III. TECHNICAL APPROACH AND RESULTS

The previous section reviewed briefly the theoretical foundations of the obsolescence loss rate. The needed data elements and sources were identified. This section will describe the development of a forecasted obsolescence loss rate and a measure of its variation from the true loss rate from year to year. This will be done by developing the concept of the forecast and the standard deviation of the forecasted errors.

The obsolescence loss rate computations that follow consider both reparable and non-reparable secondary items, even though reference (1) is specifically written for non-reparable items. Two reasons dictate this decision. First of all, reference (1) points out that the general policy statements encompass all secondary items, including, to the extent feasible, reparable items. Secondly, and of most importance, some Navy cogs contain both reparable and consumable items. At the same time, the dollar value of disposal from the FIR report is not broken down into these two categories. For example, on-hand assets from stratification of 2H cog for fiscal year 1971 reflected $227,122,000 worth of reparable assets and $52,751,000 worth of consumable assets;

whereas, the FIR report indicated $33,670,000 as the disposal dollar value, with no further breakdown. For these two reasons, this report considered reparable and non-reparable items in the review of the method for computing the obsolescence loss rate.

As noted in Section II, three years of appropriate data are available for the computation of applicable on-hand and on-order assets. Although this is not sufficient as specified in reference (1), it is considered large enough to conduct a preliminary analysis. The full range of possible cogs or groups of cogs was not used in the analysis. Rather, a representative cog from each ICP was tested. The preliminary data for these cogs are contained in TABLE I.

A cursory glance at the data will show that the values of disposals and assets vary a great deal from year to year. These years were periods of adjustment due to the decrease of operations in Vietnam.

Based on the dollar value of disposals and assets on-hand at the beginning of a fiscal year and prior years experience, the computed obsolescence loss rate is intended to be a projection for the following fiscal year. This requires procedures for forecasting and handling the error in the forecasted obsolescence rate. These two requirements are developed in the following paragraphs.

The method recommended for forecasting is exponential smoothing. It is currently used in UICP to forecast demand and other quantities; hence, it seemed appropriate to use the same forecasting procedure in this situation. The forecasting formula is:

$$\text{Current Year Forecast} = \alpha\ell_0 + (1-\alpha)\ell_1 \tag{3}$$

where

α = smoothing weight (alpha)

ℓ_0 = current year value

ℓ_1 = previous year forecast

TABLE I

RAW DATA FOR OBSOLESCENCE LOSS RATE

1N-COG

FY	DISPOSAL (t)	ASSETS (a)	ℓ_0
69	6,488,000	96,473,000	.067
70	43,059,000	84,892,000	.507
71	14,480,000	70,928,000	.204
TOTAL	64,027,000	252,293,000	.254

1H/1A-COG

FY	DISPOSAL (t)	ASSETS (a)	ℓ_0
69	9,350,379	238,442,000	.039
70	22,559,234	200,864,000	.112
71	66,348,096	193,874,000	.342
TOTAL	98,257,709	633,180,000	.155

1R-COG

FY	DISPOSAL (t)	ASSETS (a)	ℓ_0
69	76,000,000	398,060,000	.191
70	144,000,000	348,507,000	.413
71	95,000,000	305,952,000	.311
TOTAL	315,000,000	1,052,519,000	.299

Alpha, the smoothing weight, lies between zero and one. A low alpha was chosen (α = .2) in the following analysis because of the erratic nature of the data. Under exponential smoothing, a small α value mitigates the impact of the most recent data observed. Since there was only three years of data, the ratio of the sum of the three years of assets and disposals was taken as the starting point. TABLE II gives the results from the three years of forecasting.

TABLE II

FORECASTED OBSOLESCENCE LOSS RATE
α=.2

1N-COG

FY	PREVIOUS YEAR FORECAST	CURRENT YEAR FORECAST	CURRENT YEAR VALUE	DIFFERENCE
69	----	.254	.067	.187
70	.254	.216	.507	-.291
71	.216	.271	.204	.067
72	.271	.258	----	----

1H/1A-COG

FY	PREVIOUS YEAR FORECAST	CURRENT YEAR FORECAST	CURRENT YEAR VALUE	DIFFERENCE
69	----	.155	.039	.116
70	.155	.132	.111	.021
71	.132	.127	.342	-.215
72	.127	.170	----	----

1R-COG

FY	PREVIOUS YEAR FORECAST	CURRENT YEAR FORECAST	CURRENT YEAR VALUE	DIFFERENCE
69	----	.299	.191	.108
70	.299	.267	.413	-.146
71	.257	.295	.311	-.016
72	.295	.298	----	----

Review of the forecasted value of obsolescence loss rate, as shown in TABLE II, indicates that the rate does not change a great deal from year to year. For example, the forecasted value for 1N-cog by year is .25, .22, and .27. The cause of the small change, again, is the use of a small smoothing weight (α). (In fact, the change in forecasted values can be made as small as desired with the appropriate choice of alpha.) Since the forecast changed very little, it does not track a fluctuating "t/a" closely. This is borne out in the difference column, which is the result of subtracting current year value from current year forecast. This points out the problem of using such a forecasting scheme. Consider the 1N-cog, Fiscal Year 1971 forecasted obsolescence loss rate of .271 contained in TABLE II. The increase in the forecasted rate over the previous fiscal year is .055. Because of this higher obsolescence loss rate, the UICP model would compute reductions in safety level and retention level. The net effect could be the excessing of what appears to be surplus material. But note that the actual t/a ratio for Fiscal Year 1971 was .204, a figure that was actually lower than the forecasted value for Fiscal Year 1971 (.216). Thus, the UICP model would be recommending excessing of material in a year that safety level and retention level would be retained because of NAVSUP disposal policy. The mechanics of how the obsolescence loss rate affects safety level and retention level will be covered in more detail in the next section.

Alternatively, consider the forecast made in Fiscal Year 1970 for 1N-Cog, as shown in TABLE II. The forecast is smaller (.216) than the previous fiscal year forecast (.254). Therefore, during Fiscal

Year 1971, the model will compute increased safety levels and retention levels. However, in Fiscal Year 1970, NAVSUP directed disposal decisions resulted in an actual t/a ratio of .507. Thus, the model would have computed increased levels of on-hand assets at the same time that NAVSUP directed an increased rate of disposals.

TABLE II shows that the obsolescence loss rate "can" be forecasted. To show the relationship between the forecast and the actual "t/a" ratio for a given fiscal year, the standard deviation of the forecasted errors will be introduced.

Assuming that obsolescence loss rate is normally distributed, the standard deviation of the forecasted errors can be estimated through the use of the MAD (Mean Absolute Deviation). The development of the following is found in reference (3).

$$\text{MAD} = \sqrt{\frac{2}{\pi}} \approx .8\sigma \qquad (4)$$

$$\sigma = 1.25 \text{ MAD}$$

where

MAD = mean absolute deviation of forecasted errors

σ = standard deviation of forecasted errors

A forecast of MAD, in turn, can be computed for each fiscal year using the equation:

$$\text{Current Year MAD} = \alpha|\text{current deviation}| + (1-\alpha)\text{ Previous Year MAD} \qquad (5)$$

where

Current Deviation = "Difference" in TABLE II

Having forecasted the MAD for a fiscal year, the standard deviation of the forecasted error can be estimated using formula (4). TABLE III gives the results of applying these analytical techniques to the data

TABLE III

MEAN ABSOLUTE DEVIATION
$\alpha = .2$

1N-COG

FY	CURRENT DEVIATION	PREVIOUS YEAR MAD	CURRENT YEAR MAD	STANDARD DEVIATION
69	.187	.182	.183	.228
70	.291	.183	.204	.255
71	.067	.204	.177	.221

1H/1A-COG

FY	CURRENT DEVIATION	PREVIOUS YEAR MAD	CURRENT YEAR MAD	STANDARD DEVIATION
69	.116	.117	.117	.146
70	.021	.117	.094	.118
71	.215	.094	.118	.148

1R-COG

FY	CURRENT DEVIATION	PREVIOUS YEAR MAD	CURRENT YEAR MAD	STANDARD DEVIATION
69	.108	.090	.094	.118
70	.146	.094	.104	.130
71	.016	.104	.086	.104

in TABLE II. Initial values of MAD were obtained by averaging all the current deviations. This was necessary because of the lack of adequate data.

With the information from TABLES II and III, probability statements can be made about the obsolescence loss rate. TABLE IV indicates

TABLE IV

OBSOLESCENCE LOSS RATES CONFIDENCE LEVELS

1N-COG

FY	CURRENT YR FORECAST	σ	70%		80%		90%		98%	
			LOWER	UPPER	LOWER	UPPER	LOWER	UPPER	LOWER	UPPER
69	.254	.228	.016	.490	.000	.547	.000	.629	.000	.784
70	.216	.255	.000	.481	.000	.545	.000	.637	.000	.810
71	.271	.221	.051	.491	.000	.556	.000	.636	.000	.786

1H/1A-COG

FY	CURRENT YR FORECAST	σ	70%		80%		90%		98%	
			LOWER	UPPER	LOWER	UPPER	LOWER	UPPER	LOWER	UPPER
69	.155	.146	.003	.307	.000	.343	.000	.396	.000	.495
70	.132	.118	.009	.255	.000	.284	.000	.327	.000	.407
71	.127	.148	.000	.281	.000	.318	.000	.371	.000	.472

1R-COG

FY	CURRENT YR FORECAST	σ	70%		80%		90%		98%	
			LOWER	UPPER	LOWER	UPPER	LOWER	UPPER	LOWER	UPPER
69	.299	.118	.176	.422	.147	.451	.104	.494	.024	.574
70	.267	.130	.130	.404	.097	.437	.050	.484	.022	.512
71	.295	.107	.184	.406	.157	.433	.118	.472	.046	.544

various confidence levels for the obsolescence loss rate. The forecast is the mean of a normal distribution. The "upper" and the "lower" in the Table gives the interval in which the true obsolescence loss rate lies with the percentage of confidence as noted.

For instance, the 1N-cog forecast for fiscal year 1969 is .254. But there is only 80% assurance that the actual obsolescence loss rate will lie between .000 and .547 (t/a did, in fact, equal .067). Because this interval is so large, forecasting appears to be of very limited value.

If the interval were smaller, a "filtering" process could be recommended. In other words, a confidence interval could be chosen. If the computed "t/a" were to lie within this interval, it would be assumed on a statistical basis that the obsolescence loss rate had not changed. Thus, no forecast would be made. If "t/a" lay outside this interval, a new obsolescence loss rate and standard deviation would be forecasted and a new confidence interval would be computed. If use of a data base containing additional years reduces the standard deviation, this filtering process would be feasible. However, it is suspected that the variability from year to year of t/a is such that forecasts (point estimates) would be subject to a high degree of error.

The forecasted obsolescence loss rates are, in general, higher than the ones that are now in use. Thus, prior to making any recommendations, a thorough sensitivity analysis of this rate must be completed to determine the effect of these higher rates upon the computation of inventory levels by UICP.

IV. SENSITIVITY ANALYSIS OF OBSOLESCENCE LOSS RATE

The previous section contains the analysis of available data which produces obsolescence loss rates larger than values currently used. These relatively large increases raise the question of how such changes affect the inventory levels computed in UICP.

To answer the question, the impact of the obsolescence loss rate on computations in UICP is examined. This review is divided into two parts. First, the impact is measured for levels computations in the UICP model with constraints applied, and second, the impact is measured with these system constraints removed. Examples of such constraints are: (1) manufacturer's unit pack - applied to avoid expense and confusion caused by ordering less than the standard unit pack of the supplier, (2) minimum order quantity - applied to preclude ordering an item of supply more than four times per year for routine replenishment and to control the workload in the Purchase Division. But, the use of such constraints tend to make UICP insensitive to some parameter changes. Awareness of the influence of constraints to limit sensitivity led to including the unconstrained model performance in the analysis. Although an unconstrained model does not portray actuality, this type analysis does provide insight into potential changes on UICP levels computations due to changes in the obsolescence loss rate.

A. <u>The Unconstrained UICP Model</u>.

The obsolescence loss rate appears in three key equations in UICP:

1. Risk.
2. Order Quantity.
3. Retention Limit.

The risk equation affects the reorder point; the order quantity equation affects the requisition objective; and the retention limit equation affects the retention level. A brief discussion of each of these equations follows.

1. Order Quantity. When there are no constraints affecting order quantity, the classical economic order quantity (Q) is used.

$$Q = \left[\frac{8DA}{IC}\right]^{\frac{1}{2}} \tag{6}$$

where

Q = economic order quantity

D = quarterly demand

A = order cost

I = holding cost rate (contains obsolescence loss rate - $I = i + s + \ell$)

C = unit price

The amount, Q, is ordered each time the reorder point is reached. It can be seen by inspection that in formula (6), as the obsolescence loss rate increases, the holding cost rate increases, and, hence, the order quantity, Q, decreases.

2. Risk. Risk is the probability of going out of stock during procurement leadtime.

$$\rho = \frac{ICQ}{4\ k_{17}\ ED}$$

Substituting for Q from equation (6), the following is obtained:

$$\rho = \frac{(AIC)^{\frac{1}{2}}}{(2D)^{\frac{1}{2}} k_{17} E} \tag{7}$$

where

ρ = acceptable risk of stockout

k_{17} = shortage cost

E = item essentiality

Also, by inspection, it can be seen that as obsolescence loss rate increases, risk increases, and as acceptable risk increases, the reorder level decreases.

3. Retention Limit. The economic retention limit is defined as the maximum quantity of ready-for-issue stock that can be economically held in the supply system to meet future recurring demands. As such, it represents the point at which it is more economical to dispose of stock and reprocure in the future, rather than hold stock to meet future issue requirements.

The particular MARK (a material grouping in UICP based upon demand and price characteristics) in which an item is placed determines the retention limit formula that is used. But, as a generalization, the formula can be written:

$$w_1 = \min\ [4DS;\ 4D/\ell] \tag{8}$$

where

w_1 = retention limit

S = shelf life in years

ℓ = obsolescence loss rate

If the obsolescence loss rate is small, the retention limit is determined by the item shelf life. But, as obsolescence loss rate increases, the retention limit will eventually decrease.

In general, then, as obsolescence loss rate increases, on-hand stocks will decrease. Intuitively, this is just what one would expect.

4. Analysis of UICP - Unconstrained. A test was performed to determine what effect the obsolescence loss rate had on unconstrained inventory levels using actual data. A 1R cog sample (3767 items), which is described later, was chosen. The (Unconstrained CARES) parameter settings are contained in APPENDIX B. TABLE V describes the results.

TABLE V

SENSITIVITY ANALYSIS - UNCONSTRAINED UICP

	OBSOLESCENCE LOSS RATE			
DATA ELEMENT	.01	.10	.20	.77
REORDER LEVEL INVESTMENT	$829,343	$763,622	$735,510	$643,266
ORDER QUANTITY INVESTMENT	$1,137,686	$873,106	$775,018	$533,519
RETENTION LEVEL (YRS)	100	10	5	1.3
REQUISITION EFFECTIVENESS (STEADY STATE)	95%	93%	91%	82%
EXPECTED NUMBER BUYS/ YEAR (STEADY STATE)	424	608	738	1605

B. The Constrained UICP Model.

1. Order Quantity. Equation (6) shows the basic equation for computing the order quantity, while the complete UICP order quantity equation for consumables is:

$$OQ = \min \begin{cases} \min\,[4DS;\ 4D/\ell;\ 20D] \\ \max\,[P;\ D/3;\ Q] \end{cases} \tag{9}$$

where

P = unit pack

OQ = order quantity

In effect, equation (9) places bounds upon the acceptable values for OQ. It can be shown that these bounds are a function of the obsolescence loss rate. For instance, if the obsolescence loss rate is 0.4, the only items not constrained are those with a quarterly value of demand between \$3.80 and \$338S. These dollar values were obtained using the parameters listed in APPENDIX B. TABLE VI indicates that the number of items with a constrained order quantity increases as the obsolescence loss rate increases. The constraint on number of orders per month (D/3 in equation (9)) affects the general OQ equation most, since it is this constraint that operates on the value of quarterly demand (VQD) upper bound.

2. Risk. The risk equation is constrained by maximum and minimum values in UICP. The present values used by each ICP are shown in APPENDIX B.

TABLE VI

ORDER QUANTITY - CONSTRAINED

ℓ	VQD* LOWER BOUND	VQD* UPPER BOUND
.01	$ 4.0	$14,400
.10	2.0	8,228
.20	1.6	5,574
.30	2.6	4,215
.40	3.8	3,388
.50	4.9	2,833
.60	6.1	2,434
.70	7.3	2,133
.80	8.4	1,899
.90	9.6	1,710
1.00	10.8	1,557

*VQD = value of quarterly demand

3. Analysis of UICP - Constrained. A sensitivity analysis was performed on all constraints simultaneously by using various values for the obsolescence loss rate and comparing the results obtained against the present obsolescence loss rate.

At present, values of the obsolescence loss rate are different at each of the ICPs. The current values of each are shown in TABLE VII.

TABLE VII

ICP	OBSOLESCENCE LOSS RATE	
	If $D < 1.5$	If $D \geq 1.5$
SPCC	.33	.10
ESO	.10	.10
ASO	.12-.20	.12-.20

Note that the obsolescence loss rate used at ASO is variable within the specified demand ranges. This parameter has been used to control retention levels instead of order quantities and investment levels. The actual value is dependent on the SMIC (Special Material Identification Code). The actual value used in this sensitivity analysis is shown in the analyses that follows.

Combined with the obsolescence loss rates in TABLE VII, settings of .01, .20, .50, and .77 were also analyzed. The parameter settings that were used for each ICP are shown in APPENDIX B. The impact of the obsolescence loss rate changes in the constrained situation is discussed for each ICP in the following paragraphs.

a. SPCC. For SPCC, a 10% (10,127 items) sample was pulled from the 1H cog inventory and tested with the various obsolescence loss rate settings described above. TABLE VIII shows the reorder level and order quantity investment, and changes in effectiveness and workload for the various obsolescence loss rate settings. In addition, Figure 1 shows a graph of the same data elements in TABLE VIII, except it shows the percent increase or decrease of each data element for the various obsolescence loss rates with respect to the base run. The intersection of the line at obsolescence loss rate equal to .10 and the various curves represents the values for the base run.

Review of the graph in Figure 1 shows that the reorder level investment changes very little as the obsolescence loss rate changes. In the base run it was found that 60.9% of the items had a computed risk greater than or equal to .50. Since in SPCC's levels computation, the maximum risk is constrained to be not greater than .50, the computed reorder level investment does not vary greatly as the value of the obsolescence loss rate changes.

b. ESO. For ESO, two samples were pulled from the 1N cog inventory. The first sample was a universe of 1N cog best sellers (428 items) as defined in the 30 December 1970 Stratification. The second sample was a 10% sample of the non-best sellers (2561 items). All MARK 0 (items with quarterly demand less than .25) and provisioned items were eliminated from the above samples. Then the items contained in each sample were tested with various obsolescence loss rate settings. The results from each sample were combined to give estimates for the 1N cog inventory as a whole. TABLE IX and Figure 2 show the changes for the same data elements for ESO as TABLE VIII and Figure 1 show for SPCC. The intersection of the line at obsolescence loss rate equal to .10 and the various curves represent the output for the base run. The same relationships hold true for ESO as were shown for SPCC, except that the reorder level investment remained constant for all changes in the value of the obsolescence loss rate. Again this lack of change in the reorder level investment resulted from the computed risk being constrained to be not greater than .45. For ESO nearly 100% of the items hit the maximum risk constraint.

c. ASO. For ASO, a sample of 3,767 items was pulled from the 1R cog inventory. These items were consumable, non-program related, non-family related with "CJ" or "DA" SMICs. Items with a SMIC of "CJ" or "DA" (parts for A4 and A5 aircraft) have an obsolescence loss rate of

SPCC - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES

FORMULAS CONSTRAINED

DATA ELEMENT	OBSOLESCENCE LOSS RATE WHEN $D_2^* \geq 1.5$				
	.01	BASE RUN .10	.20	.50	.77
Reorder Level Investment	$9,017,881	$8,903,584	$8,841,013	$8,764,773	$8,745,237
Order Quantity Investment	$6,140,324	$5,733,843	$5,537,508	$5,307,124	$5,225,434
Steady State Effectiveness	88.86%	85.98%	83.74%	79.59%	77.59%
Steady State Expected Number of Buys Per Year	4,599	5,530	6,327	8,099	9,282

*D_2 = quarterly demand

TABLE VIII

SPCC - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES

FORMULAS CONSTRAINED

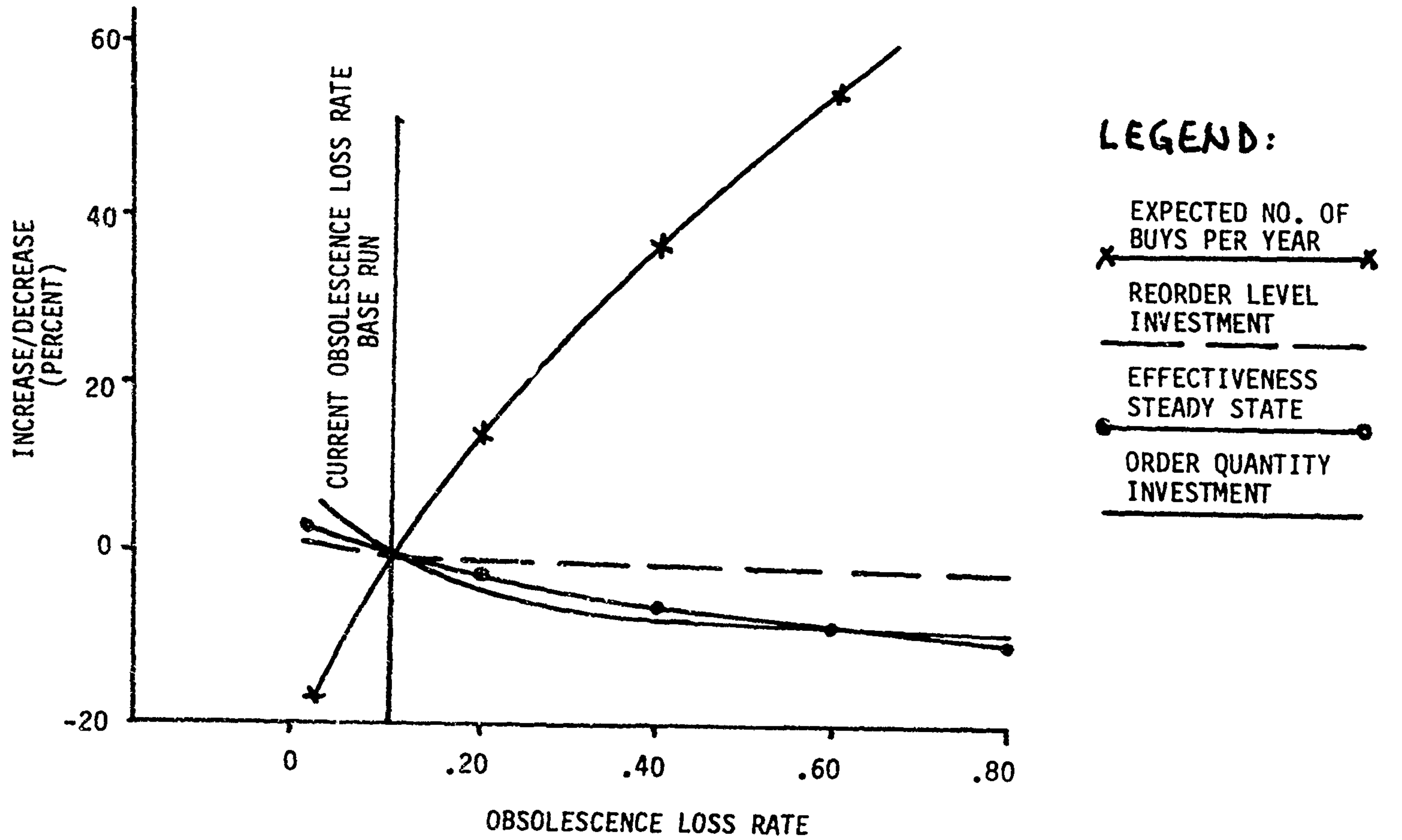


Figure 1

ESO - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES

FORMULAS CONSTRAINED

DATA ELEMENT	OBSOLESCENCE LOSS RATE WHEN $D_2^* \geq 1.5$				
	.01	BASE RUN .10	.20	.50	.77
Reorder Level Investment	$14,497,968	$14,497,968	$14,497,967	$14,497,967	$14,497,967
Order Quantity Investment	$ 4,494,598	$ 4,328,156	$ 4,134,762	$ 3,974,026	$ 3,912,040
Steady State Effectiveness	79.19%	79.20%	77.38%	74.61%	72.98%
Steady State Expected Number of Buys Per Year	3,641	3,774	4,381	5,141	5,656

$*D_2$ = quarterly demand

TABLE IX

ESO - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES

FORMULAS CONSTRAINED

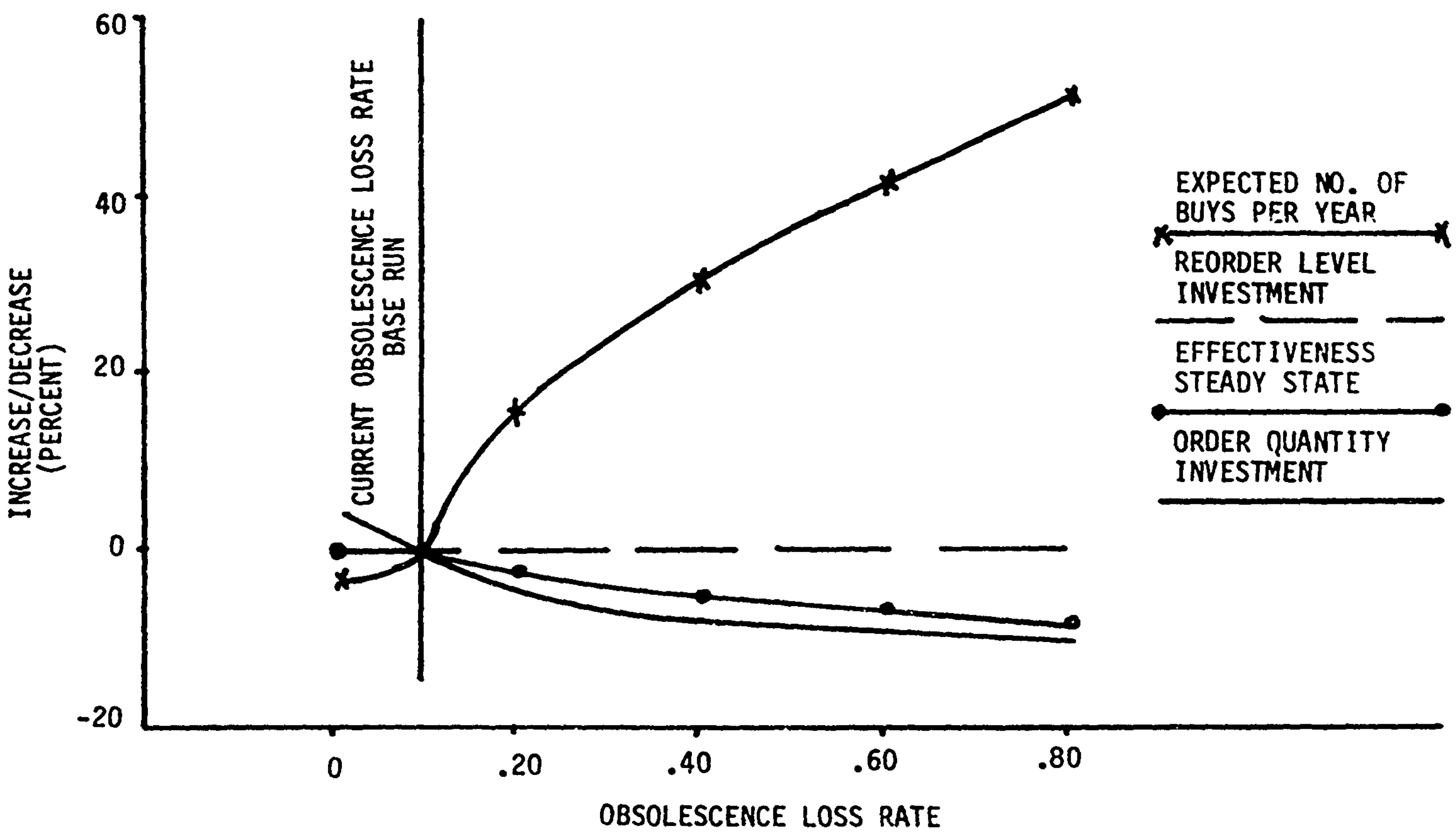


Figure 2

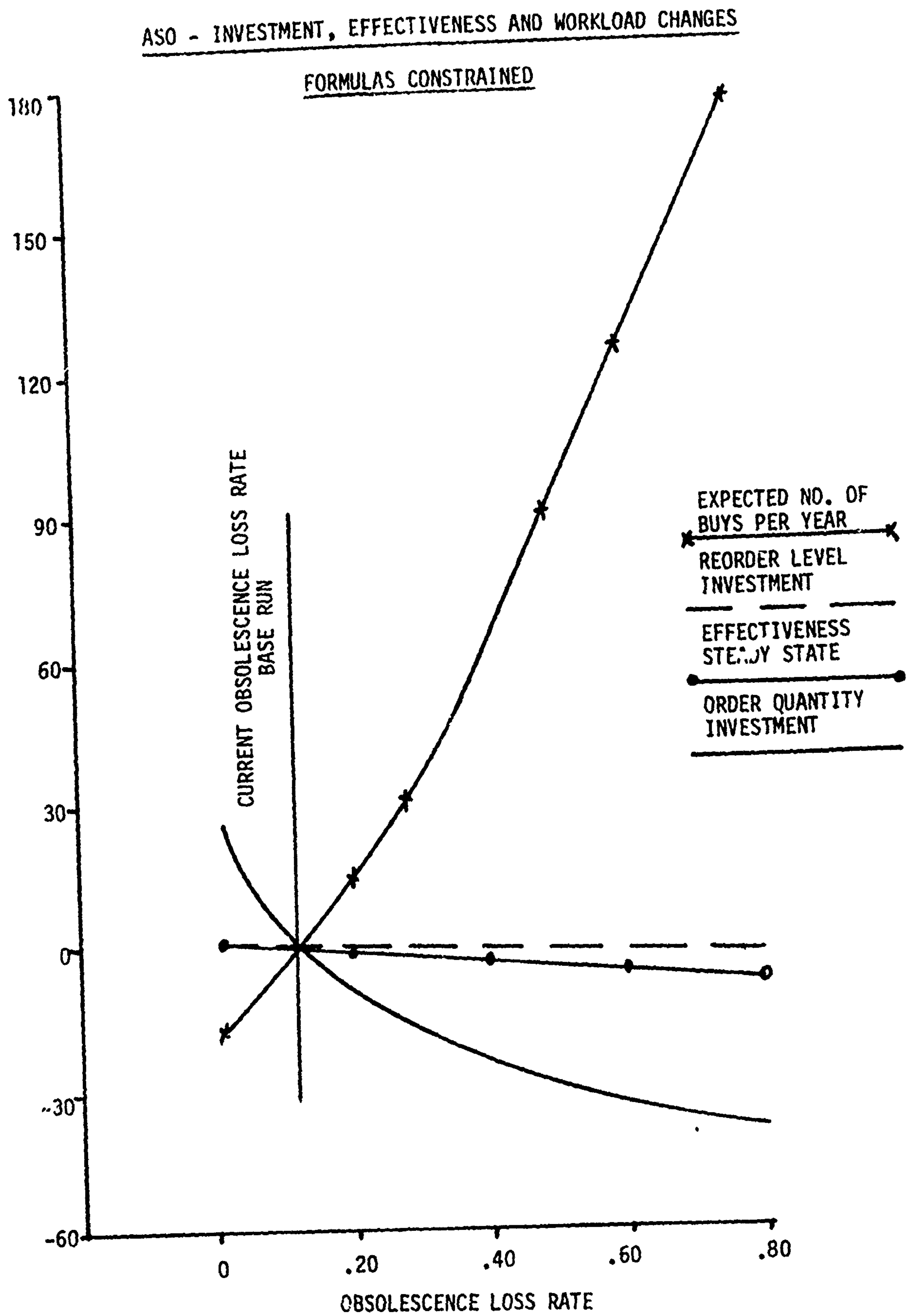
ASO - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES

FORMULAS CONSTRAINED

DATA ELEMENT	OBSOLESCENCE LOSS RATE WHEN $D_2^* \geq 1.5$				
	.01	BASE RUN .12	.20	.50	.77
Reorder Level Investment	$ 936,622	$912,827	$904,690	$892,950	$889,012
Order Quantity Investment	$1,040,931	$834,465	$755,957	$583,078	$514,128
Steady State Effectiveness	95.35%	93.39%	92.25%	88.69%	86.32%
Steady State Expected Number of Buys Per Year	539	674	762	1,310	1,884

$^*D_2$ = quarterly demand

TABLE X



ASO - INVESTMENT, EFFECTIVENESS AND WORKLOAD CHANGES
FORMULAS CONSTRAINED
180
150
120
90
60
30
0
-30
-60
CURRENT OBSOLESCENCE LOSS RATE
BASE RUN
EXPECTED NO. OF
BUYS PER YEAR
REORDER LEVEL
INVESTMENT
EFFECTIVENESS
STEADY STATE
ORDER QUANTITY
INVESTMENT
0
.20
.40
.60
.80
OBSOLESCENCE LOSS RATE

Figure 3

.12. These items were tested with various obsolescence loss rate settings. TABLE X and Figure 3 show the changes for the same data elements as TABLE VIII and Figure 1 show for SPCC. The intersection of the line at obsolescence loss rate equal to .12 and the various curves represent the output for the base run. The same relationships hold true for ASO as were shown for both SPCC and ESO. However, the order quantity investment decreases at a faster rate than either SPCC or ESO as the obsolescence loss rate increases. Also, the expected number of buys increases at a much faster rate than SPCC or ESO as the obsolescence loss rate increases. As found at the other ICPs, the reorder level investment did not change very much because the computed risk was constrained to be not greater than .45.

4. Retention Limits. Retention limits in UICP are constrained, in general, only by storage life and operate in the same manner across all ICPs. The effect of using various obsolescence loss rates on MARK I and MARK II items (low cost items) on retention levels is contained in TABLE XI.

MARK III and MARK IV items (high cost items) use a formula that is more complicated, but produce similar levels that also decrease as the obsolescence loss rate increases.

TABLE XI

RETENTION LEVELS - MARK I AND MARK II

OBSOLESCENCE LOSS RATE	COMPUTED RETENTION LEVEL (YEARS)
.10	10.0
.20	5.0
.30	3.3
.40	2.5
.50	2.0
.60	1.7
.70	1.4
.80	1.3

V. FINDINGS

DOD's method for calculating the obsolescence loss rate in reference (1) compares dollar value of material transferred to all Property Disposal Officers to total dollar value of all applicable on-hand and on-order assets. The Navy source document for the value of disposals is the FIR (Financial Inventory Report); the source document for on-hand and on-order assets is stratification. Based on these two elements, the analysis described in this report included computation of obsolescence rates for sample material inventories managed by the three Navy inventory control points. In addition, exponential smoothing was used to forecast the obsolescence loss rate based on previous years' observations. The use of a relatively small smoothing weight (α = .2) provided a steady forecast of the obsolescence loss rate from year to year; however, a marked difference existed between the forecasted value and the actual observed loss rate as computed by the method prescribed in reference (1). This was primarily the direct result of the great variation which existed in the dollar value of disposals during the period of the analysis (FY 1969-71). This period was marked with large disposals associated with the deceleration of operations in Vietnam. Although reference (1) states that unusual losses, such as excesses generated as a result of sudden decelerations of war activities, should be excluded from calculation of the obsolescence loss rate, a method for identifying such losses is not currently available. This analysis points out the need for such a method if computation of the obsolescence loss rate is to represent normal peacetime experience. In general, the following findings apply:

1. The obsolescence loss rate prescribed in reference (1) is based on all losses of material due to causes that render material superfluous to need. This definition represents much more than engineering obsolescence considerations.

2. In general, the obsolescence loss rates computed in accordance with reference (1) will be higher than the present rates used by Navy inventory control points. In many cases, these rates may be over 100% higher.

3. A data base of only three years of observations is currently available. (Reference (1) recommends that a minimum of five years be used). However, it is doubtful that the use of a larger data base would have significantly changed the results of this analysis.

4. Obsolescence loss rates computed in accordance with reference (1) were marked by high variation from year to year. This was primarily due

to large variation in the dollar value of disposals and on-hand assets, as a result of "Project Purge".

5. In general, requirements determination formulae in UICP are relatively insensitive to changes in the obsolescence loss rate because of many constraints (minimums/maximums) placed on them. Sensitivity analyses revealed that reorder level investment (safety level and leadtime demand) does not vary significantly relative to changes in the obsolescence loss rate. Order quantity investment and requisition effectiveness do vary with changes in the loss rate, however, the degree of relative variation is not large. On the other hand, the number of buys per year is highly sensitive to the loss rate.

6. An accurate forecast of the obsolescence loss rate could be made by disregarding past history and by having NAVSUP estimate this rate for each ICP. This estimate would be accurate since NAVSUP imposes the disposal dollar value goals on each ICP and has knowledge of each ICP's assets and expected MTIS. The data of the past three years indicate that the consequence of an accurate forecast would be a fluctuating number of buys and, in an unconstrained inventory system, fluctuating inventory levels.

7. A forecast smoothed with a very small alpha would produce an obsolescence loss rate that would change very little from year to year. The resultant forecast would be inaccurate on an annual basis but would not cause a fluctuating number of buys.

APPENDIX A: REFERENCFS

1. DOD Instruction 4140.39 of 17 July 1970

2. NAVSUP ltr SUP 04A11 of 7 Oct 1970

3. Brown, R. G. - <u>Statistical Forecasting for Inventory Control</u>, New York: McGraw-Hill Book Co., Inc. (1959)

APPENDIX B: PARAMETER SETTINGS USED IN CARES ANALYZER RUNS

	SPCC	ESO	ASO
Shortage Cost (λ)	25.00	.031	57.00
Minimum Risk (RMIN)	.01	.20	.15
Maximum Risk (RMAX)	.50	.45	.45
Essentiality (e)	.50	.5-.9	.50
Interest (INT)	.10	.10	.10
Storages (STR)	.01	.01	.01
Cost to Order (POC)			
Purchase Order	$24.00	$24.00	$ 68.53
Negotiated Contract	$42.00	$42.00	$127.34
Advertised Contract	$55.00	$55.00	$127.34